



TITLE:

<Notes>Ecology of Traditional Padi Farming in West Malaysia

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CITATION:

Takaya, Yoshikazu ...[et al]. <Notes>Ecology of Traditional Padi Farming in West Malaysia.
東南アジア研究 1978, 16(2): 309-334

ISSUE DATE:

1978-09

URL:

<http://hdl.handle.net/2433/55916>

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Ecology of Traditional Padi Farming in West Malaysia

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Abstract

West Malaysia is divided into seven padi regions: (1) the Kelantan-Trengganu marginal hills, (2) the upper and middle Perak region, (3) the Kelantan-Trengganu alluvial plain, (4) the Kedah marginal plain, (5) the west coastal plain, (6) the Melaka-Negrisembilan-Kuala Lipis zone, and (7) the middle and lower Pahang region.

The Kelantan-Trengganu marginal hills (1) and the upper and middle Perak region (2) have, besides wet padi, upland padi including that grown by shifting cultivation. The Kelantan-Trengganu alluvial plain (3) is a large wet-padi region, while in the Kedah marginal plain (4) padi is grown only in small mountain valleys. In these two regions the plough is very widely used. The traditional farming of the west coastal plain (5) is characterized by the use of the *tajak*, or heavy metal blade for land preparation, and double transplanting. The Melaka-Negrisembilan-Kuala Lipis zone (6) is a southern extension of the Kedah marginal plain, made up of a series of small mountain valleys. In this region the *changkul*, or hoe, is more widely used than the plough. In the middle and lower Pahang region (7), padi fields occupy the small branch-stream valleys of the Pahang river, forming scattered small clusters. The main tools for land preparation are the *tajak* and the *parang*, vestiges of the earlier shifting cultivation.

The plough is used in the Kelantan-Trengganu alluvial plain (3) and the Kedah marginal plain (4) since soil conditions are suited to plough operation in these fluvial plains. The rest of West Malaysia is dominated by swamp, and here the *tajak* is most suitable for preparing the land for transplanting, since the soil in the swampy lowland is too loose and full of woody debris for plough operation.

In a wider geographical frame, the plough is said to have been introduced from continental Southeast Asia via the series of fluvial plains along the eastern coast of the Malay peninsula southward to the Kelantan-Trengganu plain; the *tajak* has been extending from the perhumid part of insular Southeast Asia along the swampy western coast of the peninsula northward to the mouth of the Ganges. Genealogically, padi farming with the plough can be regarded as the traditional wet-padi farming originated in the continental part of Asia, whereas padi farming with the *tajak* is affinitive to shifting cultivation, although today it is true wet-padi farming.

I Geographical Setting of West Malaysia

The geographical setting of West Malaysia is briefly described from three standpoints, climate, landform and landuse, to provide background information for the

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following discussion.

I-1 Climate

The rainfall regions of West Malaysian proposed by W. A. Dale are shown in Fig. 1.

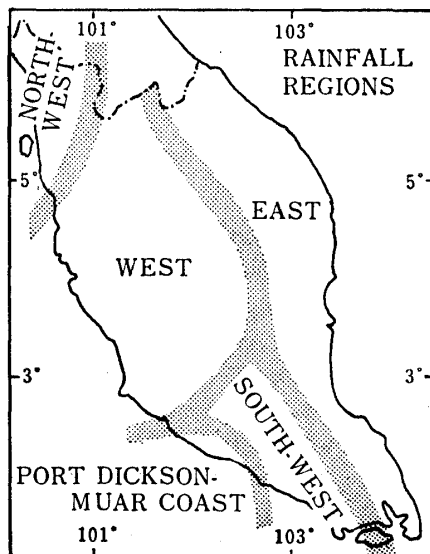


Fig. 1 Climatic Regions of West Malaysia,
Cited from Dale, 1959, p. 29

The northwest region shows a rainfall pattern typical of the southwest monsoon: maximum precipitation in October and minimum in January and February. Located to the west of the main mountain range of West Malaysia, this region does not receive the northeast monsoon. The west region, which lies directly south of the northwest region, has two maxima and two minima per year. The maxima occur during the transitional seasons of April and October/November; the minima in July and February. Because of the sheltering effect of Sumatra, the amount of precipitation is less and its distribution through the year more even than in the northwest region. Further south, on the Port Dickson-Muar Coast and in the southwest region the maxima

and minima tend to be less pronounced. The east region has an entirely different rainfall distribution pattern: the maximum precipitation occurs in the northeast monsoon season, while the southeast monsoon season is dry.

In summarizing the climate of West Malaysia, Dale says, "it [is not] possible to divide the year into wet and dry seasons, ... [for] while short dry spells may occur, they are not sufficiently long and regular in their occurrence to warrant being called dry seasons." In fact there are no or very few months in which less than 50 mm of rain falls in West Malaysia. Compared with Thailand, where the dry period extends over several months, West Malaysia's climate is distinctly moist. It is not, however, perhumid as in the case of Kuchin in East Malaysia, for instance. On the basis of these facts, West Malaysia's climate may be described as intermediate between monsoonal and perhumid.

I-2 Landform

The Malay peninsula has a central mountain range running north-south, with a coastal plain, a fan-terrace complex and hills on either side. The western coastal plain lies only several meters above sea level. The soil is composed of clay and peaty clay, and numerous tidal creeks penetrate into the plain, along which nipa and man-

grove trees flourish. The plain extends intermittently along the western coast of the peninsula to the Irrawaddy delta, and is over 10 km wide in places.

The fan-terrace complex of the west coast has a slightly undulating surface and an elevation ranging from several meters to several tens of meters above sea level. Its border with the hills is clear but that with the coastal plain is not. The higher parts of the fan-terrace complex tend to be sandy and the lower parts clayey. Although the absolute elevation is not always very low, many parts remain as swamps with peat layers, because of the poor drainability caused by the very small general slope.

The hills are mostly from 50 to 300 m above sea level and flat-topped. Geologically they comprise heavily weathered granite or pre-Tertiary sedimentary rocks, covered by lateritic soils. Many parts of the mountain zone rise to more than 1,000 m above sea level, and some portions attain over 1,500 m. In many places the slopes are steep with outcrops of granite and pre-Tertiary rocks.

The landforms to the east of the central mountain zone are similar to those of the west coast, but the fan-terrace complex and hills are smaller than their western equivalents. The east coast, however, has certain special features. One is the very well-developed beach ridges that extend along the entire coastline. The other feature, which is more important from the point of view of agriculture, is the well-developed alluvial fans formed by the deposition of large amounts of sediments by the Kelantan and Trengganu rivers. The east coast is thus characterized by large alluvial fans and sand beach ridges, in comparison with the lagoonal or swampy conditions of the west coast.

I-3 Landuse

Padi-growing is concentrated in the northern half of West Malaysia, while the southern half is occupied by rubber and oil palm plantations. The landuse pattern outlined below pertains to the northern half.

The swampy forest of the western coastal plain has been reclaimed in the last few decades by canalization of the area. Today the canal banks are lined with coconut palms and house compounds, while the rest of the plain has been converted to wet-padi land.

The landuse on the fan-terrace complex depends on the soil moisture conditions. Drainable plots are planted to rubber and oil palm, and poorly drained plots to wet padi. Further considerable areas have been left under brush; these are either seasonally inundated peaty swamps or dry swells.

In the hill area, the original *Dipterocarpus* forest has been widely replaced by rubber. Wet padi is confined to narrow stream valleys, and upland padi is also grown in places.

The mountain area is under forest. Wet padi and rubber cultivation is negligible, but shifting cultivation is reportedly still practiced.

One vital factor that does not emerge in this flat description is the absolute dominance of estate agriculture over landuse in West Malaysia. Well-drained plots are all occupied by rubber and oil palm, which are of supreme importance in the country's economy, and the rubber and oil palm gardens are intensively tended and provided with drainage systems. But the water drained from these gardens is simply discharged onto surrounding lowland, which is occupied by padi plots. Thus, padi plots are required to act as dumping grounds for water from the plantations. The result is that the padi fields have very poor drainability. This phenomenon is less distinct in the extreme north, where local farmers had opened up padi fields before rubber was introduced, but even there the padi fields have remarkably poor drainability compared with wet-padi fields in other areas of Asia, because the expansion of rubber acreage by smallholders has been pushing padi fields into even damper swales.

II Padi-Growing

Padi-growing is described for the following six areas, selected as representative padi-growing areas of West Malaysia: (1) the Kelantan plain and its marginal hills, (2) the west coastal plain, which includes such large padi-growing areas as Alor Setar, Krian and Tanjung Karang, (3) Negri Sembilan and its group, (4) the Perak river area, and (5) the middle and lower reaches of the Pahang river.

II-1 The Kelantan plain and its marginal hills

Fig. 2 shows the classification of padi fields in the Kelantan plain. The ecological conditions and methods of padi cultivation are described below.

[*Alluvial plain proper*]

The alluvial plain of the Kelantan river is perfectly fan-shaped, with a web of young and old levees and inter-levee swales which radiates from the apex. The levees are 0.5 to 2.0 m higher than the adjoining backswamps and several tens to a few hundred meters wide, and are occupied by *kampung*, or housing plots, and *dusen*, or garden tree lands. Some parts of levees are planted to rubber trees. Inter-levee swales are several tens to several hundred meters wide and many of them have a small creek, often dotted with sago clumps. Inter-levee swales are, by nature, water-accumulating troughs which carry floodwaters after heavy showers. Some of them are particularly deeply flooded and are called *alor* by local people.

The Kelantan river is the only active river on the Kelantan alluvial plain and is about 200 m wide. When the river is in spate the coincidence of rainfall on the plain and high sea tides leads to severe flood damage, as, for instance, in 1967, which saw one of the record floods in recent years. Vital roads were submerged under more than 1 m of floodwater for a week, and many domestic animals were drowned. In normal years flooding is not so extreme, but nevertheless overbank flows spread into many inter-levee swales and the high water level of the river impedes the drainage of local

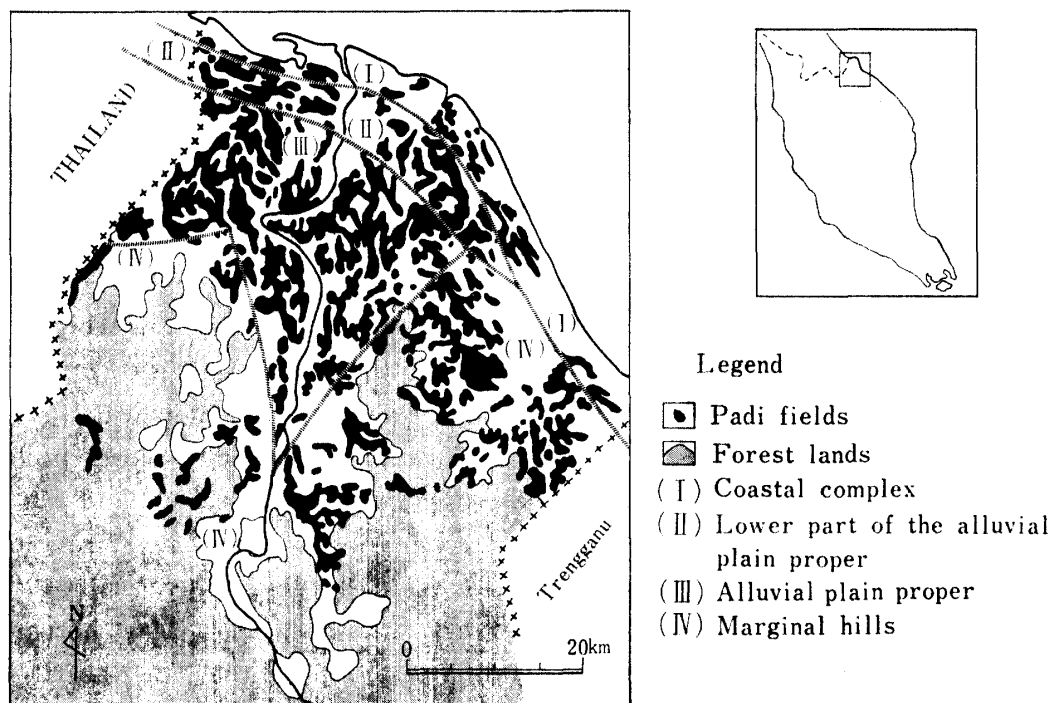


Fig. 2 The Distribution and the Classification of Padi Fields in the Kelantan Plain (The distribution is cited from the land use map published by Agricultural Division, Ministry of Agriculture and Lands in 1966.)

floodwaters.

Typical landuse on the levees and inter-levee swales is as follows. *Kampong* and *dusen* occupy the highest ground. Next are high and water-deficient padi fields, where transplanting is done late in the rainy season when water is abundant. Some of these fields receive sufficient water for planting only in very pluvial years, and in other years they serve as grazing ground for buffaloes and goats. At the middle levels sufficient water collects for land preparation in September and October and transplanting in October or November. These fields are harvested in January and February, and constitute the most important padi lands in the Kelantan alluvial plain. Nurseries, either dry or wet, are prepared on higher ground, as a precaution against unexpected floods which might damage the young seedlings. The lowest level is planted to a kind of pre-monsoon padi locally called *padi menghulu*. *Padi menghulu* is a short-term variety, which is transplanted in June or July, when the first storm showers moisten the ground, and harvested before the heavy November rains submerge the plots. It is also occasionally seen standing in December, narrowly escaping drowning with only the ears projecting above the floodwater. Although this rice is not important in terms of production, it should not be overlooked in studying the history of rice-growing in the region. Despite the swampy locations in which it is grown today it appears to have a close affinity to the dry-land padi cultivated in hilly areas.

The traditional farming in the alluvial plain proper has undergone some modification in recent years with the implementation of the KEMUBU irrigation project. Water is now pumped from the Kelantan river and distributed onto fields, permitting double-cropping of padi in some parts of the plain.

[*Coastal complex*]

The coastal complex comprises sets of beach ridges and inter-beach-ridge swales running parallel to the coast. Typical beach ridges in this area are 100 to 200 m wide and 1 to 3 m high and composed of pure sand whose surface is often snow-white due to tropical podsolization. The dominant vegetation on the beach ridges is coconut palm. The inter-beach-ridge swales, locally called *baroh*, are also 100 to 200 m wide. Here a single padi crop is raised, although salt water intrusion occasionally causes problems since the coastal complex is located outside the irrigation area. This land has only recently been opened for padi-growing, the reclamation of *gelam* forest proceeding rapidly in the 1940s (Dobby, 1951a, p. 239). In the early days cultivators reportedly preferred longer-period varieties, but today nearly all the farmers grow short-period varieties. Rice is transplanted in October and harvested in February or March.

[*Lower part of the alluvial plain*]

The lower part of the alluvial plain has flat and low-lying tracts before it meets the coastal beaches. This portion is more or less intermediate in character between the alluvial plain proper and the coastal complex. Inundation lasts for relatively long period but salt water intrusion does not occur. According to local farmers, padi was traditionally cultivated by at least three methods. Up until World War II broadcasting was practiced in the vicinity of Chabang Empat. The seed was broadcast on dry land at the end of dry season, germinated with the first showers of the rainy season and grown through the several months of inundation, and was harvested in April or May of the following year. This is very similar to the process seen today in such major deltas of Southeast Asia as the Chao Phraya of Thailand and the Mekong. And it is interesting that the broadcast seeding of this "floating rice" was practiced only in areas with a predominantly Thai-speaking population. Another method was the normal transplanting of 'heavy rice' or rice of long maturing period. This seems to have been practiced nearer the sea where inundation is of longer duration but shallower. Dry nurseries were prepared in July and the seedlings transplanted on ploughed and puddled fields in August or September. The crop was harvested in the following May. The third method involved a pre-monsoon padi that was nearly identical to *padi menghulu*. According to Dobby (1951a, p. 239), a strain locally called as Taiwan variety, which has as short maturity period as 100 days and is resistant to brackish condition was popularly used for this method.

The recent irrigation scheme, however, has changed this cropping pattern. Water is now available even during the driest season and the incursion of sea water in April

has been stemmed, with the result that multicropping of padi is now possible. New varieties of short growth period have replaced the traditional long-term varieties. Now the gazetted cropping calendar shows the first crop from November to February and the second crop from April to August.

In all the subregions mentioned above, the land is prepared by ploughing, except in a small number of plots having a very soft clay foundation, which are cleared by *tajak*. Transplanting is always done by hand; the *kuku kanbin* is not used.

[*Marginal hills*]

The marginal hills which surround the Kelantan alluvial plain are made up of terraces, hills and small valleys. Here, four types of padi-growing are practiced: *padi chedong*, *padi tugal*, *padi tabor* and *padi huma*.

Padi chedong is the normal transplanting of wet padi seen everywhere in the Kelantan alluvial plain.

Padi tugal is the sowing of a dry-land padi by dibbling with a digging stick known locally as *tugal*. The ground is seldom leveled and the dikes around land parcels are very poor or nonexistent. When showers moisten the soil, usually in May or June, the farmers start ploughing. They plough the land three or four times at intervals of about 10 days and then dibble the seeds in lines. After sowing, they must weed the land several times until the padi plants grow thick enough to suppress the weeds. They prefer to harvest in September or October, well before the commencement of the north-east monsoon, but if the rain is late the whole operation may be delayed by a month or two.

One very interesting feature of *padi tugal* is that it is cultivated either wet or dry, although it is always dibbled on dry land. In well-drained places the padi is cultivated throughout as dry-land padi, but at the bottom of slopes it is water-logged in the later stages of growth and cultivated as wet padi. And at intermediate levels, the choice between wet and dry cultivation rests entirely with the cultivator (Craig, 1933, p. 664). *Padi tugal* often used to be intermixed with maize and cow pea (Craig, 1935, p. 372), but this mixed cropping is no longer popular.

The *padi tabor* is the broadcasting of dry-land padi. Ploughing is repeated several times, as in the case of *padi tugal*, but seeds are broadcast and covered by harrowing. Because of the broadcasting, weeding cannot be done. This is a rather crude but labor-saving type of dry-land padi-growing. The land was reportedly often fallowed for one or two seasons after one or two seasons in *padi tabor* (Craig, 1934, p. 179).

The ecology of *padi tugal* and *padi tabor* is interesting. They are planted only on good soils with good texture and high water-holding capacity; seldom on alluvial soils in valleys. Thus the cultivation of *padi tugal* and *padi tabor* can be said to depend on soil properties rather than the availability of water. It is often said that one of the important points in the cultivation of the crop is to avoid weeding after rain. The

implication is that puddling soils after rain causes destruction of soil structure and consequently results in the loss of water-holding capacity. *Padi tugal* and *padi tabor* are typical upland crops.

Padi huma is the shifting cultivation of a dry-land padi.

The Trengganu plain has similar topography and farming systems to those in the Kelantan plain, except for the fact that in Trengganu wet nurseries are preferably established on land adjacent to fresh-water swamps or in the beds of abandoned river channel (Jackson, 1972, p. 84).

II-2 Western coastal plain

The west coast of West Malaysia has several large coastal plains which are physiographically similar. Some of these, such as Tanjung Karang, Krian and Province Wellesley and Alor Setar, are major padi producing areas. Before describing each plain, it may be better to show a schematized geomorphological profile which is more or less applicable to all the coastal plains of the west coast. Fig. 3 shows a profile from hills (1) to the coast (7). At the foot of the hills (1) occur taluses and small fans (2), and, lower down, terraces (3) whose surfaces are partly podsolized (4) and partly covered by peat layers (5). The terraces in turn merge with the Recent alluvial plains (6), composed dominantly of brackish clay often with intercalated toxic acid sulphate soils. Peat and acid sulphate soils are not very good for padi-growing, nor is this low-lying and swampy area suited for human inhabitation. Thus the coastal plains has been left unutilized until recent years. The following are descriptions of some representative coastal plains.

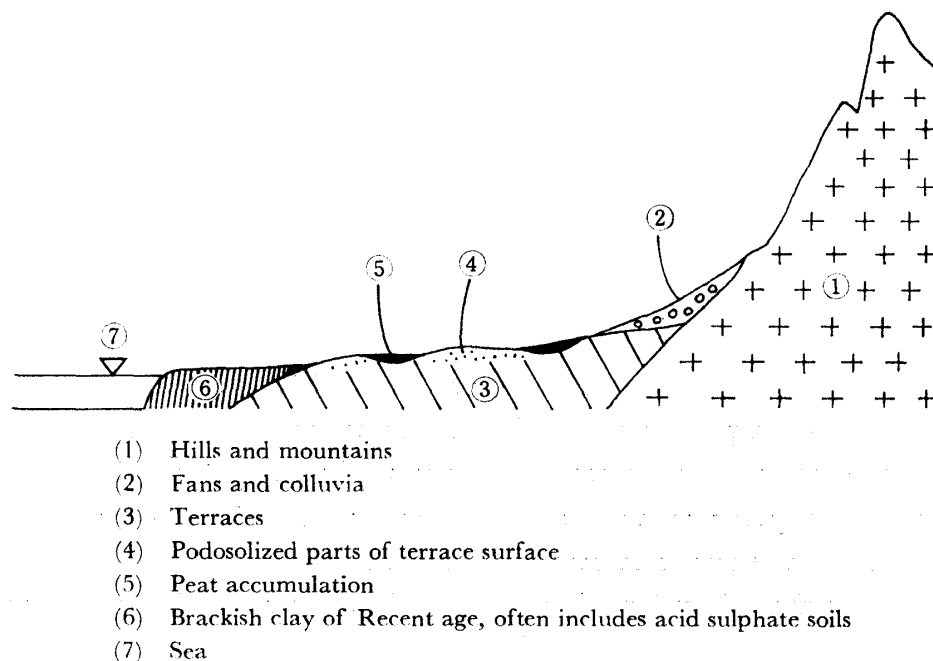


Fig. 3 Schematized Cross Section of the Coastal Plain

〔*Tanjung Karang*〕

Traditional padi-growing in the area is the single-cropping of rainy-season padi. The rearing of seedlings here is special, taking place in two stages. The first nursery consists of banana or coconut leaves or sometimes grass matting, spread out on relatively elevated ground, mostly in house compounds or at the road side, and plastered with 1 inch of clay, onto which seeds which have been soaked in water for 3 days are broadcast. This is a dry nursery. People believe that by placing the nursery on high ground they can save the seedlings from drowning during unexpected rain. After a week or ten days the seedlings, which are about 10 cm long, are uprooted and transplanted into the second nursery. The second nursery is prepared in a padi field and is wet. A small plot is selected as the nursery ground for parcels of two or three fields, and the young seedlings are transplanted on it in hills of about 40 plants. After about a month in the second nursery, the hills are uprooted and subdivided into 10 to 20 smaller clumps which are transplanted into the fields. This final transplanting is often done with the help of a *kuku kanbin* or two-pronged transplanting stick. According to J. C. Jackson this double transplanting method was introduced to the west coast by Banjarese immigrants sometime in the third quarter of the nineteenth century (Jackson, 1972, p. 91).

Why is the double transplanting needed? It is done to minimize the labor required to deliver the seedlings from the nurseries to the padi fields. If the seedlings were raised in one large central nursery until large enough to be transplanted into the final fields, the delivery of the grown seedlings to remote fields would be quite laborious, particularly in those soft clay areas where neither enough farm roads nor firm dikes are available. Land is traditionally prepared with a heavy metal blade called a *tajak*, which is swung by hand to rip up vegetation at or slightly below ground level. The first cutting is in the early rainy season and the cut grasses and sedges are left on the fields for about a month until the second cutting, when they are removed and piled up on the dikes. The second cutting is not as laborious as the first, since the young shoots are soft and not very dense. Right after the second cut, the second transplanting or the final transplanting is made. Recently motorized puddlers have been gaining popularity, and nowadays land is commonly prepared by a combination of puddling in the early rainy season and the subsequent cutting by *tajak*. The plough is not used here.

After transplanting there are no important tasks until harvest time. Reaping is done by sickle, and the harvested padi is carried almost immediately to the threshing ground in the field, where the sheaves are beaten several times against a short ladder set in a large tub some 4 feet wide and 3 feet deep, and the grain is spread on a mat to dry in the sun. In fine weather the grain will dry in one day and can then be stored in a store cabin with raised floor.

Although the area is flat and low-lying, even swampy in places, the greatest

problems in padi-growing stem from water shortage in the planting season. This leads to the delay of transplanting, often by months, and these water-deficient years tend to coincide with years of pest and insect damages. In the traditional cropping system transplanting is done in June and harvesting in January, but this has changed greatly since the introduction of double-cropping.

[Krian]

The Krian coastal plain was opened up under the first large-scale reclamation program in Malaysia, started in 1900. Today it forms one of the most advanced padi lands in Malaysia, yielding two crops annually.

Padi farming in the Krian plain is very similar to that in Tanjung Karang, also being characterized by the use of the *tajak* and double transplanting. Formerly, triple transplanting was also reportedly practiced in the low-lying coastal area, and seedlings were raised in floating nurseries, although these practices are no longer popular. The following is a description of a floating nursery.

A "floating" seed bed (*rakit*) is prepared by cutting down the fallow weed growth and piling it in a long strip, 3 to 4 feet wide, until the pile stands an inch or two above water level. On this foundation, sufficient clay is plastered to make the whole into a compact bed, on the top of which a thin layer of mud, rich in organic matter, is placed. Should the level of the water in the field rise, the nursery rises and thus maintains its surface above water level.

(Economic Branch of Dept. of Agr., 1939, p. 43)

The plough is not used, and transplanting is done with a *kuku kanbin*.

[Kedah]

This is the most advanced padi area in Malaysia. Almost the entire area is under double-cropping and the government cropping schedule is kept without sizable delays. In fact this standardization of the cropping schedule over a large area is a distinctive feature of the Kedah plain; in other places, even those categorized as double-cropping areas, the stage of growth of plants varies widely from plot to plot. When we visited there in late November, the plants in every field in the Kedah plain were about to flower.

Before the completion of the MUDA project which converted the whole plain into the double-cropping area, both *tajak*-cum-double transplanting and plough-cum-single wet nursery methods were seen. Transplanting was usually done in July and harvesting in January or February; but the cropping season fluctuated greatly from year to year depending on the rainfall pattern. Local farmers stated that the long-term padi was absolutely dominant, but Dobby reports short-term padis were also grown by small-holders as "insurance padi" (1951b, p. 299). These were transplanted at the same

time as the long-term strains and ripened before the commencement of the southwest monsoon.

Geomorphologically, the coastal plain of Kedah may be divided into two portions: the riverine portion and lagoonal portion. The riverine portion has distinct levees and considerable local relief. This type of land occurs nearer the mountains, where the general slope is steep. Soils are of lighter texture and are called "hot soils" locally due to their quick-drying nature (Dobby, 1951b, p. 294). This nearly corresponds to the place of plough-cum-single wet nursery method. The lagoonal portion is very flat and low-lying, but because of the lack of creeks it has a water shortage during the dry season. The prevalent soils are peaty and acid sulphate soils. This is the place of *tajak*-cum-double transplanting. The riverine and lagoonal portions roughly correspond to Zaharah's "old land" and "new land" respectively.¹⁾ The riverine portion has been longer settled and cultivation is generally more intensive than in the lagoonal portion.

A zone about 1 km wide facing the seacoast has a special environment: inundation there is more prolonged than in the lagoonal portion proper. During World War II a very short-term padi, locally called Taiwan padi, was reportedly introduced into the area by the Japanese. People cut down vegetation by *tajak* and grew two crops a year, one from May to August and one from September to January (Dobby, 1951b, p. 299). But there was a constant threat of sea water invasion, particularly during the westerly storms, or *angin barat*, in September and October. This has since been relieved by the construction of coastal embankments and estuarine gates.

[Province Wellesley]

Province Wellesley is similar to the Kedah plain in the sense that it has both *tajak*-cum-double transplanting method and plough-cum-single wet nursery method. For instance, along the lower reach of the Murbok river, the principal tool for land preparation is the *tajak* and typical double transplanting is observed, but just east of this tract extend tracts where ploughing and puddling are done by buffalo and wet nurseries are set for single transplanting. Double transplanting based on two wet nurseries is also seen in a few places. The island of Penang also shows intermediate features: *tajak* is the only tool used but wet nurseries for single transplanting and two wet nurseries for double transplanting are also occasionally seen. The *kuku kanbin* is used for transplanting.

1) Kedah during the traditional period was divided into two regions in respect of her settlement geography. The first region consists of the "old land", that is, the areas of the State that were first settled by the traditional population. The other consists of the "new land" or the areas that were newly or in the process of being settled. While one area indicated the habits of a long established agricultural settlement, the other reflects all the bleakness and hardship of a pioneer community.

(Zaharah binti Haji Mahmud, 1966, pp. 50-51)

II-3 “Sawah” and its equivalent

Local farmers gave various answers to our question about the definition of “*padi sawah*”. One farmer said that it was an irrigated padi field located in the rather well-drained parts of a valley bottom. Another explained that “*padi sawah*” refers to fields which have functional bunds to retain inundation, in contrast to “*padi paya*”, of which the bunding merely marks property limits. Many people, after describing the character of “*padi sawah*”, added “You’d better go to Negri Sembilan or Melaka if you want to see *sawah*”.

[*Negri Sembilan and Melaka*]

The most typical *sawah* is 100 m to 200 m wide and a few kilometers long, extending along the bottom of a mountain valley. Irrigation canals run along the border of the fields and the hillside. Sometimes one or two natural creeks 1 to 2 m wide may run through the *sawah*. In this case the creeks are often installed with a series of small dams and weirs. Parceling bunds are high and strong enough to allow people to walk on them and to hold irrigation water at a depth of about 10 cm. Sometimes a canal may branch off from a padi field and enter a grove of trees. Such canals usually lead to a village compound in the grove, where clean water is kept flowing through a well-maintained waterway and used for all types of domestic uses. In the *sawah* areas all kinds of human activities depend on swiftly flowing mountain streams.

In Negri Sembilan, nurseries are prepared in May, many of them dry nurseries. In either case, the nurseries are prepared in the same place for many years and fenced in with split bamboo to keep out ducks and buffaloes. Sometimes several families share a nursery. Formerly, people preferred to keep seedlings in the nursery for a long period, sometimes as much as 70 days, but today the standard nursery period is less than a month. In the traditional system, the farmers start preliminary land preparation in February and work for about 2 months, after which they stop for about a month, then begin the final land preparation, which continues until the time of transplanting in June. The most important tool used for the land preparation is the *changkul* or hoe. If the weeds are very tall, they are cut by *tajak*, the soil is turned by *changkul*, and the cut weeds are trodden into the soil. Formerly, buffaloes were driven into the fields to do this work (Economic Branch of Dept. of Agri., 1939, p. 54). This *melunyah* has, however, disappeared. Transplanting is done by hand.

In the traditional cropping system, transplanting is done in June or July and harvesting in December, but recently this has changed greatly and now transplanting is done in December and harvesting in May. Double-cropping of padi is also increasing. The farmers attribute the dissemination of double-cropping to the introduction of non-photosensitive varieties of rice which can be planted at any time of year. The improvement of irrigation also seems to have considerably influenced padi-growing. The region has long been provided with irrigation systems, and their improvement has

involved the replacement of several small weirs by a big one. Three or four of brush-wood weirs are being replaced by a large concrete weir. Double-cropping is often found just below these newly built concrete weirs.

In Melaka state the padi fields are more distant from the mountains and less typical of *sawah* than the Negri Sembilan fields described above, although they are categorized as *sawah* by the local people. Streams along which *sawahs* develop are small and short in Melaka, and consequently the water flow usable for irrigation is seasonal and unstable. A *sawah* valley usually has three portions with different hydrographic conditions. The upper reaches lack irrigation canals because catchments are too small, and fields are rain-fed. Planting season fluctuates greatly according to the arrival of rain, and in dry years people are often unable to transplant due to the shortage of water. The middle reaches are the most representative portion in Melaka. Water collected in the upper reaches is most carefully utilized here. The planting season may fluctuate from year to year but once the water comes the whole portion is transplanted almost at one time. There is little variation in the growth stage of plants in this portion of the *sawah* valley. The lower portion is low and flat, often being located not far from the seacoast. Because of the location, water is available in greater quantity and for a longer period than in the other portions, but the features of the *sawah* are absent and the landscape resembles that of the coastal plain.

In part of Melaka, the plough is said to be used occasionally, but in Negri Sembilan we never heard of ploughing although buffaloes are said to be used to draw a *pengilling*, or roller, after tilling the soil by *changkul* (Economic Branch of Dept. of Agr., 1939, pp. 52-54).

[Other "sawah" areas]

Padi fields resembling *sawah* occur in other areas, too. These fields lie along medium to small streams, which serve for irrigation. Parcels are small and of irregular shape, and similar to the *sawah* of Negri Sembilan in general appearance. The following is a brief description of padi-growing in the selected localities shown in Fig. 4.

Loc. 1: Kg. Kurong Batang, 5 km north of Kangar

Although there are irrigation canals, double-cropping is impossible because streams dry up during the dry season. Fields are ploughed by buffalo. Nurseries are wet, and single transplanting is practiced. Transplanting season fluctuates from July to October depending on the commencement of the rainy season.

Loc. 2: Oran, 10 km east-northeast of Kangar

Double-cropping has been possible since 1974. Buffalo is used for ploughing and puddling, although the tractor has been rapidly replacing it. Nurseries are of the wet type and transplanting is single. The *kuku kanbin* is not used. Fields located on lower ground are reckoned by local farmers to be better than those on higher ground because of the higher availability of water and the clayey soil.

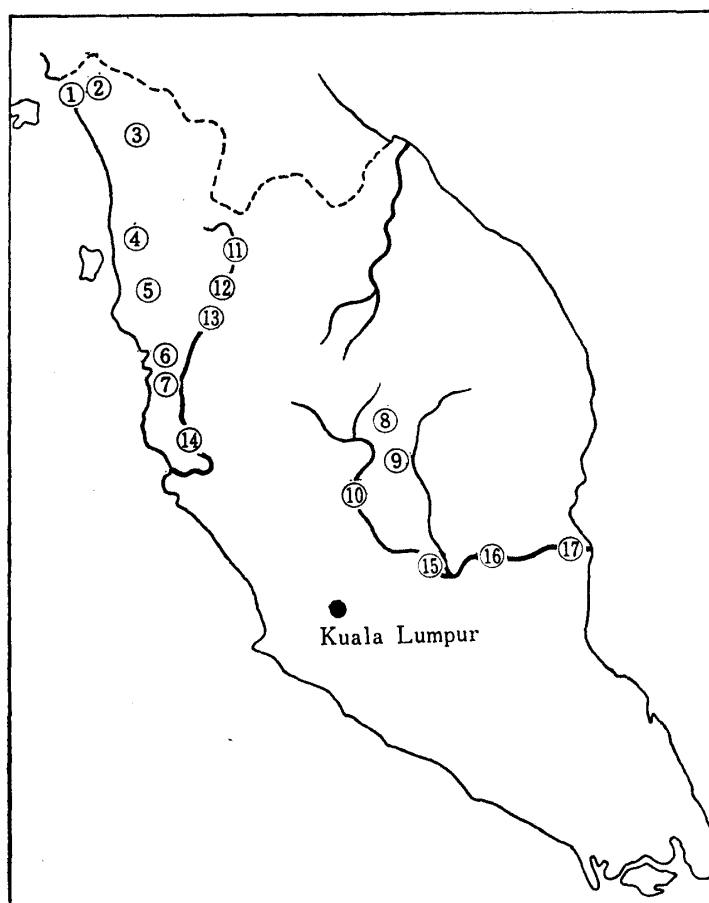


Fig. 4 A Map Showing Localities whose Padi Farmings are Described

Loc. 3: Tekai, 8 km south of Nerang

Single-cropping is practiced with the aid of poorly maintained irrigation canals. The soil is ploughed by tractor and then puddled by buffalo. Single transplanting is done by hand in September and October and harvesting is in January and February.

Loc. 4: Kg. Pasir, 5 km east of Sungai Patani

This is a single-cropping area with very poor irrigation. Ploughing and puddling is done by either tractor or buffalo, but in heavy clay plots the *tajak* is used instead of the plough. In some plots, tall grass and weeds are cut by *tajak* before ploughing. In this case the vegetation is cut several centimeters above ground level, unlike in the *tajak* area proper. Single transplanting is common but double transplanting is not rare. Formerly, transplanting was done in July and August and harvesting in December and January, but recently preference has shifted to transplanting in November and harvesting in May. This cropping calendar, however, fluctuates considerably depending on the rains.

Loc. 5: Kg. Tasek, 10 km southeast of Bt. Mertajam

This is one of the most well irrigated padi areas in this vicinity. Double-cropping

was first introduced by Japanese soldiers in 1944, but became popular only after 1964. Cattle and buffalo are used for ploughing and harrowing. The *tajak* is seldom used. Double transplanting is still common. The first nursery can be either wet or dry, but the second nursery must be of the wet type. Ten or fifteen days after the second transplanting some farmers weed their fields.

Loc. 6: Sungai Benchai, 13 km south of Taiping

Until about 1970, the area was a single-cropping area with traditional varieties transplanted in August. Today the area forms a so-called 3-crops-in-2-years area; that is, the area has the potential for double-cropping but the availability of water is rather unreliable so that the dry season crop is expected once in two years. In the traditional system, cattle and buffalo are not used and the land is prepared by *tajak*. Recently tractors have been introduced but they are used only at relatively high places where the foundation is firm; at low places the *tajak* is still the only tool used for land preparation. Double transplanting is still quite common. The *kuku kanbin* is used.

Loc. 7: Beruas

Fields are well irrigated and have been double-cropped since 5 years ago. Cattle and buffalo are not used, the land being prepared by *tajak*. Double transplanting is still practiced.

Loc. 8: Pagar Sasak, 20 km north of Kuala Lipis

Double-cropping is practiced in places. Land is prepared by *changkul* and *tajak*; cattle and buffalo are not used. Nurseries are dry and single transplanting is practiced.

Loc. 9: Batu Balai, 5 km west of Jerantut

There are many communally maintained irrigation canals, but they are used for supplementary irrigation of rainy-season padi, and double-cropping is not practiced. Cattle and buffalo are not used for tilling the soil, which is done by *changkul* and, if necessary, *tajak*. Dry nurseries are prepared in July and 40-day-old seedlings are transplanted by hand. The varieties planted are mostly of long maturity, taking about 6 months between transplanting and harvest.

Loc. 10: Kg. Dong, 3 km north of Raub

Padi fields are irrigated with stream water, but double-cropping is limited by the lack of usable perennial streams. Land is prepared by *changkul* and *tajak*. Formerly, *lanyak*, a way of puddling soil by chasing a herd of buffaloes into fields, was practiced. Today, 20-day-old seedlings are pulled from the wet nurseries and transplanted into the main fields in April.

It is interesting to note that all the above localities have *sawah*-like scenic features but that the technologies for land and nursery preparation differ from place to place. Very roughly, buffalo ploughing is used in the northern portion and *tajak* and *changkul* are used in the southern.

II-4 Perak river area

The Perak river rises in the border mountains between Malaysia and Thailand, flows through mountainous terrain for about 150 km, then from near Parit passes through open land for another 80 km to the seacoast. Along the length of the river from the head to the mouth occur four types of landuse. In its uppermost reaches, the river flows through deep, steep-sided valleys and shifting cultivation is seen scattered on the slopes. In the middle reaches, the river flows through rolling to hilly terrain, and permanent upland fields occur here and there along its course. This middle reach is divided into two sub-portions: the upland-padi-dominated upper sub-portion and the cassava-dominated lower sub-portion. Below Parit the river crosses flat land, forming well-developed natural levees. In these lower reaches wet padi is grown. These four kinds of landuse along the river are described below.

[The upper reaches]

Typical shifting cultivation of the upper reaches can be seen around Gerik [Loc. 11], and along the roadside between Nami and Sik of the Muda river drainage. Steep slopes prevail in this portion, and small patches of less steep slope are selected for the shifting cultivation. According to local people, after burning the forest, land is planted to upland rice for the first year and replanted to cassava for the following two to three years. Sometimes maize or cassava is planted from the first year instead of padi. Padi is dibbled in holes in April and harvested in November.

Shifting cultivation is, however, disappearing since national law prohibits this destructive form of landuse. In this area it is giving way to rubber plantation. In fact, many cassava fields or even padi fields also contain a mixture of rubber seedlings. One thing to be added is that the shifting cultivators along the road are Malay. Orang Asli, or indigenous hill people, practice a similar type of shifting cultivation (Iskandar Carey, 1976, pp. 180-181), but they dwell in the remote jungle and it is difficult for highway travelers to encounter them.

[The middle reaches]

The middle reaches have more complex physical conditions as well as landuse. Along the river course is a hilly zone a few kilometers wide, which merges with steep mountain slopes on both sides. The steep portion has a rocky ground surface, while the hilly portion has lateritic or, in places, latosolic soils. The steep slopes are covered by forest, the hilly portion by upland fields. Rubber is planted along the topographic break between the steep and hilly portions.

The landuse on the hilly portion is interesting. For instance, at Selat Pagar [Loc. 12], about 27 km south of Gerik and 45 km north of Kangsar, swells are dominated by cassava and swales by upland padi. In the lowest parts of the swales, upland padi cultivation contains an interesting feature; seed is dibbled on unleveled land in the normal way, but the plants are inundated deeply during the tillering stage. Similar

inundation occurs in the cultivation of *padi tugal* in the marginal hills of the Kelantan region, as mentioned earlier. Also interesting is that the varieties of padi grown in these low places are very primitive; plants are stout and large, often the stem is over 8 mm in diameter, and areal roots emerge even from the third node from the top along with tillers. Black and red padis are quite common.

This primitive padi-growing, however, is giving way to more sophisticated techniques a little downstream. The first beautiful wet-padi fields are seen at Kg. Sumpitan [Loc. 13], about 5 km downstream of Selat Pagar. The landform at Kg. Sumpitan is similar to that of Selat Pagar. It has a steep portion covered by forest, a hilly portion with upland padi, and a rubber belt in-between. But the special feature is the occurrence of real wet padi in the lowest portion. This forms a small valley 50 to 100 m wide, which is very sharply demarcated from the adjoining hill slopes by an irrigation canal about 50 cm wide. The hill slopes are planted to upland padi varieties similar to those just described, but the valley is planted to a high-yielding variety of wet padi. The valley soil is tilled by *changkul* and relatively young seedlings are transplanted once. This wet-padi field in Kg. Sumpitan was created in mid 1950s, before when agriculture was just as primitive as in the lowest part of the hill zone at Selat Pagar today. According to local farmers, all padi-growing in the middle reaches of the Perak river used to be like that in Selat Pagar, and this is being gradually transformed to wet-padi culture like that found in Kg. Sumpitan today.

Further south in the middle reaches, the Perak valley widens and the hilly topography gradually becomes terrace-like. This is the lower sub-portion of the middle reaches of the Perak. The landuse pattern also changes; upland padi disappears and cassava becomes the absolutely predominant crop. The lower sub-portion may thus be called a cassava area.

(The lower reaches)

The lower portion of the Perak flows through a plain, and levee and backswamp are the main topographic units. Levee is covered by garden trees and backswamp by wet padi. Kg. Gajah [Loc. 14], about 20 km upstream of Telok Anson, is typical. In this locality, padi fields can be divided into two groups: high and low level fields. The high level fields lie about half a meter higher than the lower level fields and are planted to short growth period varieties, while the latter are planted to long growth period varieties. Worth mentioning is the history of these fields. According to an aged informant of Kg. Gajah, his field was cleared of forest about 70 years ago by burning the trees. For four years after the burning, the plot was planted to upland padi by dibbling, without ploughing. Sowing was done in May and harvesting in November. From the fifth year, the plots had to be ploughed because the weeds became too vigorous and prevented simple dibbling. Land was ploughed by buffalo, weeds were removed, and then seeds were dibbled into holes made with a *tekai* or digging stick. This was

continued for about 30 years, during which period the land was gradually leveled and the bunded wet-padi fields seen today were constructed. Once the plot had been converted to wet-padi fields, ploughing was abandoned and the use of the puddling roller was introduced at the high level and the *tajak* at the low level. Even today ploughing is not practiced.

This history is very interesting because the flat and low-lying alluvial plain was opened with the technology of upland cropping.

II-5 Middle and lower Pehang

Padi fields different from those described above can be found, but most are scattered and of very small area. The only important area is the middle and lower reaches of the Pahang river. The middle reaches of the Pahang river start at Jerantut and extend to near Pekan where the river meets the coastal plain. The middle reaches of the Pahang river show erosional features; and levee and backswamp topography is absent. Hills abut the main river course and there are few places suited for padi cultivation. Only in the swampy, narrow valley bottoms of the side streams does padi-growing seem feasible. These side streams do not receive floodwater from the Pahang main course, but they inundate deeply during December through February due to bad drainage. In these swampy valleys so-called *paya* padi-growing is practiced.

The lower reach is very short. The river cuts through the coastal plain, which is made up of sand bars and lagoonal swales. Padi fields are located in swales bounded by the natural levees of the Pahang river and beach ridges, and receive floodwater from the Pahang main course during rainy season. Descriptions of padi cultivation in some representative localities are given below.

Loc. 15: Kg. Kertau, 5 km east of Temerloh

This is one of the widest swampy valleys on the middle reaches of the river. It lies above the floodwaters of the Pahang river in normal years, but may be inundated in years of very high flood. Fields are all rain-fed and single-cropped. Land preparation is done by *tajak*, and the plough is not known. Dry nurseries are prepared in March and the seedlings are transplanted in May. Double transplanting is not practiced, and the *kuku kanbin* is not used.

Loc. 16: Lubok Paku, 2 km south of Maran

The padi fields are located at the junction of a side stream with the main river course. But the ground is too high to receive water from the Pahang and the stream is too small to serve as a source of irrigation water, and thus the fields are rain-fed. The land is commonly prepared by *tajak*, never by ploughing, although occasionally buffaloes are employed to trample the land (*lanyak*). Dry nurseries are prepared in March and seedlings are transplanted only once, after 40 days. Both long and short growth period varieties are planted. Some short growth period varieties ripen in as short as three months after sowing. Formerly, the villagers reportedly planted substantial areas to

upland padi, but this practice had disappeared by the time of the survey.

The padi cultivation of the middle reaches of the Pahang river resembles that of the west coastal plain and of Negri Sembilan in the absence of buffalo ploughing, but was for a long time characterized by a peculiar nursery system locally called *semai darat*. This system has now given way almost entirely to modern methods, but only 10 years ago was still quite popular on this portion of the river. The following is a description of *semai darat*.

Actual initiation of each rice cycle begins with the selection and clearing of nurseries. Every year, a new site is chosen to supply the needs of from ten to twenty household plots. Ideally, the site should be centrally located close to, but not within the *payas*, with access to running water and shade from afternoon sun. After agreement is reached, the householders working together fell, stack and burn off all natural vegetation completely, a process taking about one month on an average. Sometimes these tasks are undertaken by members of a single household, working an area exclusively for their own needs. On completion, each household broadcasts its own seed over an area of about half an acre. Then the soil is generally, but not invariably raked over with a hoe to reduce losses from birds. Subsequently, some weeding may be undertaken, but farmers seldom resort to watering except in unusually dry seasons. Normally, germination and initial growth of rice seedlings is left entirely to moisture in the soil and to natural rainfall.

(Ho, Robert, 1967, pp. 49-50)

About 40 to 50 days later, the seedlings are transplanted into the *payas*. Ho suggests that the method is closely connected to *padi huma* or dry-land padi farming (Ho, 1967, p. 5).

Another aspect of padi-growing in the region is what appeared to be the shifting cultivation of wet padi occasionally encountered along the Temerloh-Kuantan highway, which is quite similar to what was called *tenggala* padi-growing in literature of the late 19th century.

... *tenggala* padi was cultivated on alluvial tracts on the lower reaches of the Pahang river. The land in this type of cultivation was planted for three to five seasons in succession and then left fallow for the same period. Although yielding less than wet padi cultivation, *tenggala* cultivation was suited to slightly higher ground where wet padi cultivation was impracticable and had distinctive padi strains which had a shorter ripening period.

(Ghee, Lim Teck, 1977, p. 37)

We did not ask whether these padi fields which seemed to be a kind of shifting type were called *tenggala*, but the general landscape of fields with prolific weed growth interspersed with fields planted to wet padi were suggestive of *tenggala* cultivation.

Loc. 17: Tanjung Pahang Tua, 3 km northwest of Pekan

This lies on the lower reach of the Pahang. Padi is planted in a lagoonal swale which opens into a backswamp of the Pahang river. The ground is flat and low-lying and subject to flooding by the Pahang, but the depth and duration of flooding depend on the microrelief, which attains about one meter.

Although the buffalo was recently introduced for ploughing and puddling, traditionally land was prepared either with *parang*, or machete, and *tajak*, and sometimes also *changkul*, or, more commonly, by *lanyak*, which is still practiced by some farmers (Horii, 1977, p. 107). Interviewees reported that about 40 buffaloes belonging to several villagers are driven into a field to trample the sedge-covered mud, churning the sedge and mud together ready for transplanting. A group of 40 buffaloes can finish 4 acres in 4 hours, from 6 to 10 o'clock in the morning. *Lanyak* is done a second time after a 10-day interval, then seedlings raised in a dry nursery are transplanted. Transplanting is done in September and harvesting in March.

Recently double-cropping was introduced. Under this new system, the second crop should be planted in March and harvested in July. But in fact many fields are left idle even during the main season, which our informant claimed was due to the drain of young workers to the more attractive urban centers.

According to the following report, another type of wet-padi cultivation, *paya simbah*, in which the fields were cleared by either *parang*, *tajak* or *changkul*, and then broadcast with seeds, was practiced on the lower reaches of the Pahang.

Paya Simbah. — The jungle or secondary jungle growth is first felled, cleared and burnt during the dry season. Frequently the burning is unsatisfactorily done. At the commencement of the rainy season the wet seed is broadcast on to the semi-wet *paya* and then left entirely to the mercy of the weather till harvest time. Cultivation, beyond perhaps an occasional weeding, is never done. Usually 5 to 7 gallons of seed are required to plant up an acre.

This wasteful method of padi planting owes its origin to the Sakai, a great number of whom are found in the upper reaches of the main rivers on the coast. After 2 or 3 successive plantings the land is abandoned and new areas are acquired for the same purpose.

(Economic Branch of Dept. of Agr., 1939, p. 57)

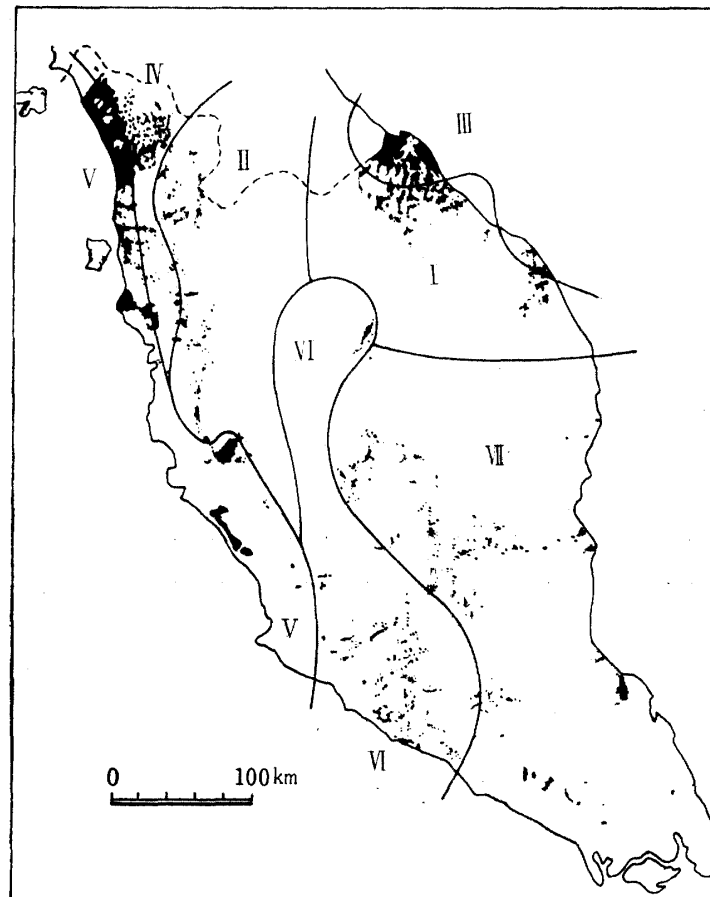
III Environmental Adaptation of Planting Techniques

III-1 Padi regions

Based on the descriptions in the previous section, West Malaysia can be classified into seven padi regions as shown in Fig. 5.

1. The Kelantan-Trengganu marginal hills.
2. The upper and middle Perak region.

3. The Kelantan-Trengganu alluvial plain.
4. The Kedah marginal plain.
5. The west coastal plain.
6. The Melaka-Negrisembilan-Kuala Lipis zone.
7. The middle and lower Pahang region.



- (I) Kelantan-Trengganu marginal hills
- (II) Upper and middle Perak region
- (III) Kelantan-Trengganu alluvial plain
- (IV) Kedah marginal plain
- (V) West coastal plain
- (VI) Melaka-Negrisembilan-Kuala Lipis zone
- (VII) Middle and lower Pahang region

Fig. 5 Padi Regions of West Malaysia

The Kelantan-Trengganu marginal hills have various types of padi cultivation including upland rice cultivation. The upper and middle Perak region also has upland padi. Both of these regions are therefore characterized by upland padi cultivation, which requires the use of the *tekai* or digging stick. Physiographically, the hill slopes as well as valley bottoms are extensively utilized as agricultural ground. Both perma-

nent and shifting types of hillside agriculture are observed.

The Kelantan-Trengganu alluvial plain forms a wet-padi area in which buffalo ploughing is practiced. The Kedah marginal plain is also a wet-padi area with buffalo ploughing. Thus these two regions are characterized by buffalo ploughing. Both plains are typically fluvial in origin, young and old natural levees are well developed, and soils consist of sand and clay without organic materials.

In the west coastal plain including the lowest reach of the Perak river, land is prepared not by buffalo-drawn plough but by *tajak* or heavy metal blade, and double transplanting is practiced. Physiographically, the west coastal plain differs from the Kelantan-Trengganu alluvial plain, being lagoonal rather than fluvial in origin. In this region, streams are lacking and soils are of heavy clay with ubiquitous peat and toxic acid sulphate components.

In the Melaka-Negrisembilan-Kuala Lipis zone land preparation by *changkul* or hoe is popular.²⁾ Dry nurseries and single transplanting are the standard techniques. Padi cultivation is confined to stream valley with swift-moving flows. Hill slopes are seldom used for agricultural activities, but narrow valley bottoms are carefully parceled into many small fields with well maintained dikes and irrigated with water tapped from the streams.

Land preparation in the middle and lower Pahang is also not done by buffalo ploughing, but by *tajak* and *lanyak*. Padi is planted in small swampy valley bottoms of side streams of the Pahang. Most of the region is, however, still covered by vast jungle and the padi fields are scattered and poorly maintained. The *tenggala*, or shifting wet-padi cultivation, and *semai darat*, or dry nurseries made on burnt forest, are characteristic.

The environments of the seven padi regions and the characteristic land preparation

2) The buffalo-drawn plough is not unknown in this zone, but is not used appreciably in the existing farming method. For instance, C. O. Blagden reports knowledge of the plough among Melakan farmers:

— In olden time the order of planting operations was as follows: — First the elders had to hold a consultation with the Pawang; then the date was fixed; then *Maulud* prayers were read over the “mother seed” and benzoin, supplied by the pawang: was burned; then all the requisites for rice planting were got ready, viz: —

- (1) A strong buffalo (to pull the plough);
- (2) A plough with its appurtenances (to turn over the earth and the short weeds);
- (3) A harrow with its appurtenances (to level and break up small the clods of earth left by the plough);
- (4) A roller with its appurtenances (to knock down the long weeds, such as sedges, in fields that have lain fallow for a long while);
- (5) A wood cutter's knife to mend any of the implements that may get out of order at the time of ploughing;
- (6) A hoe to repair the embankments and level the higher ground;
- (7) A scythe to cut the long weeds;
- (8) And a whip to urge the buffalo on if he is lazy.

(Blagden, 1897, pp. 297-298)

methods employed are summarized below;

<i>Padi Regions</i>	<i>Environment</i>	<i>Technologies</i>
Kelantan-Trengganu marginal hills	hill slopes & valley bottoms	<i>tekai</i>
Upper and middle Perak region	hill slopes & valley bottoms	<i>tekai</i>
Kelantan-Trengganu alluvial plain	alluvial fan	plough
Kedah marginal plain	mountain valleys	plough
West coastal plain	swampy lowland	<i>tajak</i>
Melaka-Negrisembilan-Kuala Lipis zone	mountain valleys	<i>changkul</i>
Middle and lower Pahang region	swampy valley bottoms of branch streams	<i>tajak & lanyak</i>

III-2 Ecology of the plough and *tajak*

Tools can be used most efficiently when they are suited to the physical conditions in which they are used. The plough, for example, can be used efficiently on the fluvial plain, while the *tajak* is effective on swampy lowland. Before discussing the adaptation of these tools to the ecological conditions, let us examine the conditions themselves. Soils on the fluvial plain are composed of clay, silt and sand, and seldom contain such bulky organic components as tree trunks and roots. By contrast, the peaty ground of the swampy lowland is full of fresh and half-rotten roots and trunks, and sometimes the top and subsoils contain only organic matter. It must be emphasized that some tropical peats are not merely an accumulation of herbaceous plant matter like that often found in the temperate zone, but contain debris of woody plants including trunks and roots. The plough is totally unsuited to use on such peaty ground, because the buried woody debris would hinder its smooth operation. In fact, it would not be possible to move the plough an inch if caught on such debris. The only way to prepare such land for transplanting is to clear it by cutting down weeds or tramping them into the ground. The *tajak* and *lanyak* are thus suited to cope with peaty conditions.

The plough is suited to fluvial ground. Soils on fluvial plain often harden when desiccated, especially if the clay content is high. This hard soil must be loosened mechanically before transplanting. This mechanical loosening of the soil cannot be done by *tajak*. The best way is to plough and puddle the soil after it has been moistened by showers. *Lanyak* can achieve the same result, but less efficiently than ploughing and puddling. Of course, as many writers have pointed out, the loose nature of swampy soils is another factor hindering the use of the plough drawn by heavy animals. Mechanically, sediments deposited in a swampy environment have a much lower bearing capacity than those deposited under fluvial conditions.

Climatic conditions also influence the selection of tools, though not as directly as the soil. In the perhumid environment, vigorous weed growth poses a problem. Because of the prolonged wet conditions, the soil itself remains soft and loose, but the

ground surface is densely covered by perennial plants. Here, the removal of weeds becomes more essential in land preparation than tilling the soil. Where aquatic plants predominate, they are removed with the bare hands, while in sedge and grass-dominated plots, cutting by *tajak* is the most common practice. In the monsoonal climate plant growth is not as active as in the perhumid area due to the long dry period during which soils desiccate entirely. Even if weeds put forth shoots during the rainy season, they are mostly annual plants with shallow and feeble roots, which are killed more efficiently by tilling the soil than by cutting them.

The conclusion drawn from the above analysis is that the plough is suited to fluvial plains having a monsoonal climate and the *tajak* is for swampy lowlands with a perhumid climate.

III-3 Distribution of the plough and *tajak*

In the framework of Southeast Asia, the core area of distribution of the plough is continental Southeast Asia, and that of the *tajak* is the tropical rain forest of insular Southeast Asia. For instance, in the Chao Phraya and the Mekong river basins, the plough is common, and this is quite understandable because they are fluvial plains with monsoonal climate. On the other hand, in East Malaysia and most part of the outer islands of Indonesia, the *tajak* is used. Wet padi in these areas, though its absolute acreage is very small, is located on swampy lowlands.

In West Malaysia, the plough is most commonly used in the Kelantan and Trengganu alluvial plains and in the foothills of Perlis, Kedah and Perak states, and the *tajak* is employed in the rest of West Malaysia. The question arises whether the distribution in West Malaysia of the plough coincides with the fluvial and monsoonal environment and that of the *tajak* with the swampy and perhumid environment. The answer is, as described before, a qualified yes; although the plough is used only in the fluvial area, climatic conditions have little influence on its use, because the climate of West Malaysia is intermediate between monsoonal and perhumid. We know at present that the Kelantan-Trengganu area and the foothills of Perlis, Kedah and Perak states have the fluvial type of land on which the ploughing technique could readily be adopted, but that the same technique has failed to penetrate further south because of the more swampy and perhumid conditions.

The western coast of the Malay peninsula has more extensive swampy land than the eastern coast, and this environment suites the *tajak*. In fact, the *tajak* is employed all along the western coast of the peninsula and the mainland Southeast Asia as far north as the mouth of the Ganges. On the other hand, the eastern coast, which has a chain of fluvial fans like the Sai Buri, Pattani and Utaphao alluvial fans of Thailand, is plough zone. Although scattered spots of *tajak* operation are found, the main technique is ploughing on the eastern coast.

It may be said that the plough technique has spread down from continental South-

east Asia as far as the Kelantan-Trengganu area along the eastern coast, and the *tajak* technique is spreading mostly along the western coast of the peninsula up into the core area of continental Southeast Asia.

III-4 *Tajak*, double transplanting and shifting cultivation

Tajak, double transplanting and shifting cultivation seem to be closely related to each other. As Robert Ho pointed out, *paya* farming in the middle and lower Pahang region is very clearly a vestige of shifting cultivation (Ho, 1967, p. 51). Let us reconsider the case of the Perak river.

In the village of Kg. Gajah, the fields were for considerable period cultivated as upland fields by use of the *tekai*, before being converted to the present-day wet-padi fields. The switch from upland farming to wet-land farming has clearly taken place here. The same is probably true for a much wider area.

Today the Perak river has shifting cultivation on its upper reaches, permanent upland farming on the middle reaches and wet-padi cultivation on the lower reaches. And the transition from shifting cultivation to wet-padi growing is very smooth. This profile from the upper to the lower reaches does not itself tell anything about the genealogy of the padi cultivation of the area, but considered in combination with our observations at Gajah, it strongly suggests that the history of padi cultivation in this area has been one of transformation from shifting cultivation to wet-padi growing.

It is also interesting that the *parang*, or hatchet, used by shifting cultivators in the upper reaches is gradually replaced by the *tajak* used by wet-padi cultivators in the lower reaches. The *parang* and *tajak* are similar in that both have a large blade used to cut or mow down plants. It is not difficult to imagine that both have a common origin and are even interchangeable. Thus the *tajak* might be said to have originated as a tool of shifting cultivators. Another point of interest is that the double transplanting technique popular in the lowermost reaches of the Perak river and its adjoining coastal plain might also be related to shifting cultivation. In the double transplanting method, the first transplanting is occasionally done by punching holes with a *tekai*, or digging stick. This use of the *tekai* is similar to its use in shifting cultivation.

The above evidence may be too weak and insufficient to conclude that the *tajak* and double transplanting originated in shifting cultivation, but we think they are closely related and can envisage a direct connection between non-plough agriculture and shifting cultivation.

III-5 *Changkul*

Similar questions about the *changkul* must remain unanswered. We described the close relation between the *changkul* and the *sawah*, and we know that the *changkul* is the tool most suited to *sawah* ecology. But we do not know its genealogical background. We anticipate that more information will be obtained from studies in Sumatra and Java.

Acknowledgments

This paper is a part of the result of a field study entitled "Ecology, New Technology and Rural Development in rice-growing communities" carried out between November 12 and December 26, 1977, with the cooperation of the Department of Economics and Administration, University of Malaya, with a Science Research Grant from the Ministry of Education of Japan. Among those who helped us, we particularly want to express our gratitude to Prof. Mokhzani A. R., the Deputy Vice-Chancellor of the University of Malaya, who arranged the project on the Malaysian side, and Prof. Leo Fredericks of the Faculty of Economics and Administration, who smoothened the project through close cooperation and enlightened us through academic discussions.

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